Phytobase: a tool for the integrated synusial approach of vegetation classification at regional to national scale

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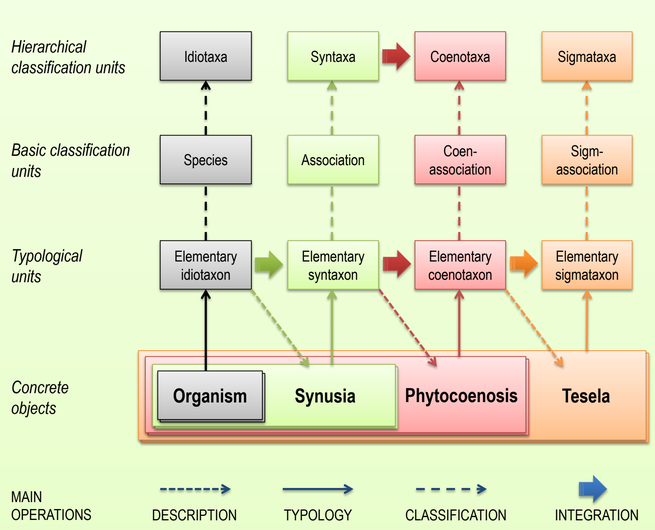
Integrated Synusial Phytosociology

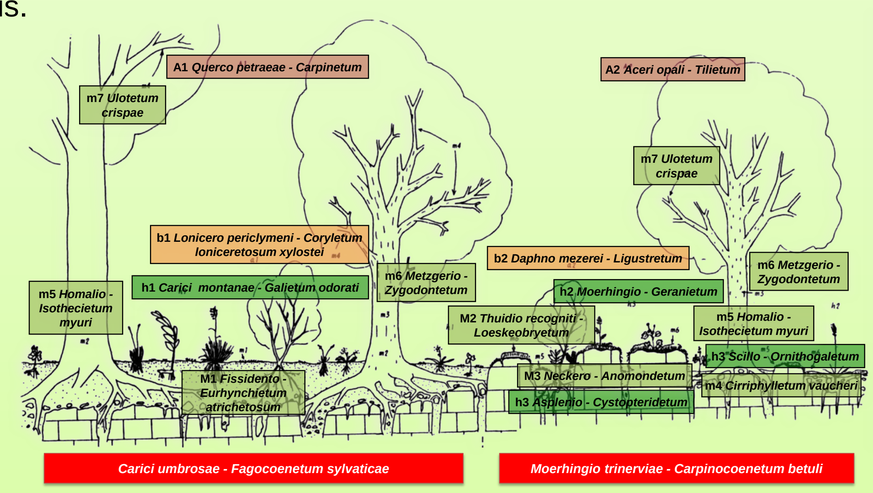
Integrated Synusial Phytosociology (ISP) considers vegetation as organized in nested hierarchical levels, each of them being potentially described in a classification system (1, 2, 3).

The first, finest, level is the **synusia**, a concrete plant community composed of plant species co-occurring in a local similar environment, with comparable size and habitat use. *Phytobase* distinguishes three categories of synusiae, i.e. tree, shrub, herb and moss synusiae, classified into **elementary syntaxa**.

Synusiae are integrated into **phytocoenoses**, the second level of vegetation description, based on a list of synusial elementary syntaxa co-occurring in a given phytocoenosis. Phytocoenoses are classified into **elementary coenotaxa** according to their synusial composition (elementary syntaxa or alliances).



Concepts of the Integrated Synusial Phytosociology.

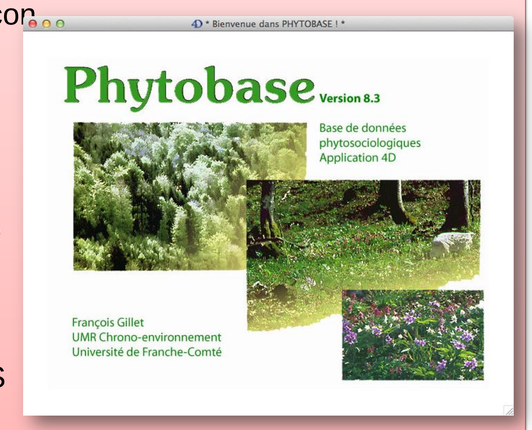


Synusial organization of two forest phytocoenoses in the French Jura Mountains.

(1) Barkman J.J. 1980. Synusial approaches to classification. In: Whittaker R.H. (ed.), *Classification of plant communities*, pp. 111–165. W. Junk, The Hague, NL.
(2) Gillet F., de Foucault B. & Julve P. 1991. La phytosociologie synusiale intégrée : objets et concepts. *Candollea* 46: 315–340.
(3) Gillet F. & Gallandat J.D. 1996. Integrated synusial phytosociology: some notes on a new, multiscalar approach to vegetation analysis. *Journal of Vegetation Science* 7: 13–18.

Phytobase: a relational database for ISP

Phytobase is a relational database management system (RDBMS) devoted to the management of vegetation survey data, following the concepts of the ISP. This application has been developed in the 4D environment (4) from the 1990s at the University of Neuchâtel, at EPFL and now at the University of Besançon.



Phytobase is freely available from the *Tela-botanica* website (5), including a sample of relevés and a user guide (6). It is used by more than 200 registered users in Europe and registered in the GIVD metadatabase (7).
The current standalone application (version 8.3 for Windows or Mac OS X, built with 4D v13) has a user interface in French language but an English version is planned to allow a broader diffusion to the international community of vegetation scientists.

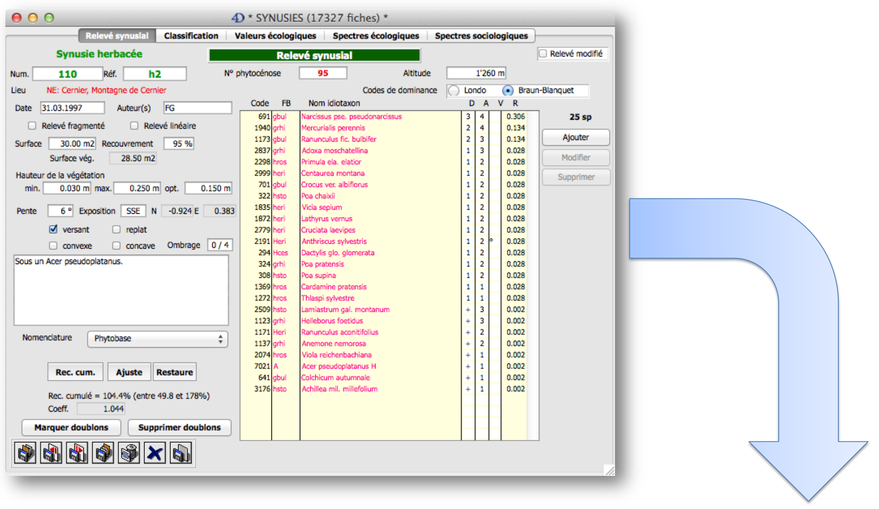
(4) http://www.4d.com
(5) http://www.tela-botanica.org/page:liste_projets?id_projet=18&act=documents&id_repertoire=16428
(6) Gillet F. 2014. *Guide d'utilisation de Phytobase (version 8.3), base de données phytosociologiques.* Université de Franche-Comté, Besançon.
(7) http://www.givd.info/ID/EU-00-015

Phytosociological and ecological diagnostic tools

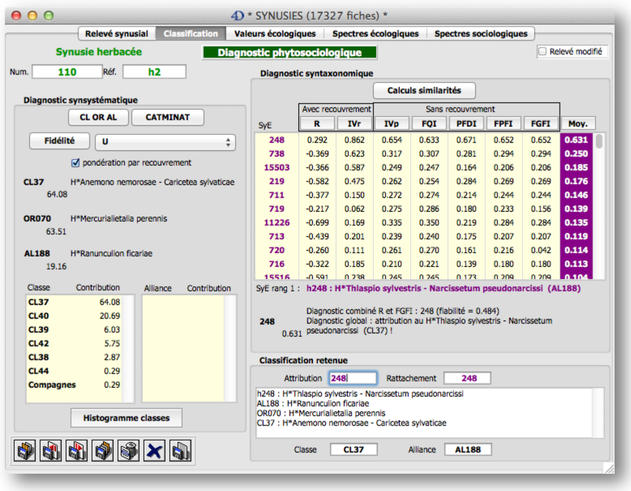
A comprehensive diagnostic of synusial plot records is implemented in *Phytobase*, including:

- **Synsystematic diagnosis**: assignment to a class, an order and an alliance based on the relative number or cover of characteristic and differential species according to Julve's *baseveg* classification system (8, 9);
- **Syntaxonomic diagnosis**: assignment to an elementary syntaxon stored in the database, based on the combination of various indices (10);
- **Ecological diagnosis**: ecological indicator values (according to Landolt (11), Ellenberg or Julve), life forms, CSR strategies, taxonomic diversity indices, pastoral value, etc.

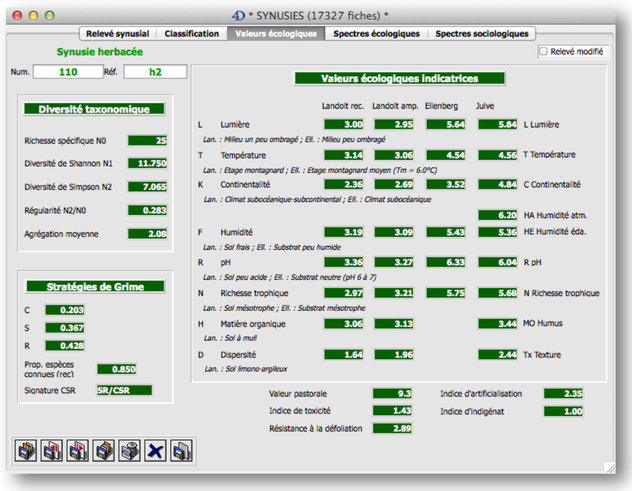
Synusial plot record



Phytosociological diagnosis

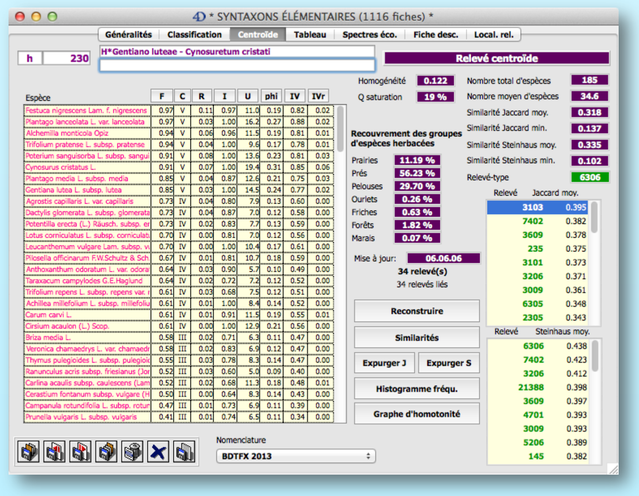


Ecological diagnosis



Phytosociological and ecological diagnostic of a synusial relevé in Phytobase 8.3.

Synusial plot record



Centroid relevé and homogeneity assessment of a synusial elementary syntaxon in Phytobase 8.3.

Each elementary syntaxon or coenotaxon is described by the centroid of all plot records that were assigned to it. This centroid relevé includes fidelity indices (e.g., Phi (12), IndVal (13)) for species or elementary syntaxa, used in phytosociological diagnoses. An assessment of compositional homogeneity, taking or not into account dominance, is also implemented.

(8) Julve P. 1993. Synopsis phytosociologique de la France (communautés de plantes vasculaires). *Lejeunia* N.S. 140: 1-160.
(9) Julve P. 1998-2015. *Baseveg – Répertoire synonymique des unités phytosociologiques de France.* Available online: http://perso.wanadoo.fr/philippe.julve/catminat.htm
(10) Tichý L. 2005. New similarity indices for the assignment of relevés to the vegetation units of an existing phytosociological classification. *Plant Ecology* 179: 67-72.
(11) Landolt E. et al. 2010. *Flora indicativa – Ecological indicator values and biological attributes of the flora of Switzerland and the Alps*. Haupt, Bern.
(12) Chytrý M., Tichý L., Holt J. & Botta-Dukát Z. 2002. Determination of diagnostic species with statistical fidelity measures. *Journal of Vegetation Science* 13: 79-90.
(13) Dufrêne M. & Legendre P. 1997. Species assemblages and indicator species: the need for a flexible asymmetrical approach. *Ecological Monographs* 67: 345-366.

Main applications

Phytobase has been applied to various ecosystems (wood-pastures, forests, floodplains, wetlands and grasslands) in many regions, mostly in Switzerland and in France. ISP and *Phytobase* have proved particularly useful when studying structurally and dynamically complex vegetation, such as wooded pastures and alluvial forests, which are poorly described by the Braun-Blanquet approach.